

Concerns with Concrete Roof Decks / Moisture Release Present Challenges

by Mark S. Graham, Vice President, Technical Services, National Roofing Contractors Association (NRCA)

Newly poured and, in some instances, existing structural concrete roof decks present unique moisture migration problems for the roofing industry. In a number of instances reported to NRCA, significant amounts of water have been found in roof systems within as soon as several months after construction. In most of these situations, it was determined the roof membranes were watertight and not the sources of the moisture infiltration. In many of these situations, this moisture infiltration resulted in damage to the roof systems, including adhesion loss, issues with water-based and low-VOC adhesives, metal and fastener corrosion, insulation R-value loss and microbial growth.

Concrete basics and dryness

When mixed, poured and formed, normal-weight and lightweight structural concrete contain significant amounts of water. As concrete cures and hardens, it consumes large amounts of water through hydration and evaporation. For example, a 4-inch-thick concrete slab will release about 1 quart of water for each square foot of its surface area.

Previously, the roofing industry had used a minimum 28-day drying period as a guideline for applying roofing materials over newly poured concrete decks. This 28-day period coincided with the curing time of concrete before it is tested for design compressive strength. In reality, there is little to no correlation between this 28-day period and concrete's true "dryness."

Similar to the roofing industry, the concrete industry has seen significant advances in technology regarding concrete mix design, placement and curing. For example, the use of admixtures in concrete mix designs can accelerate concrete's curing and strength development but retard the release of concrete's free moisture. Similarly, weather conditions, covering newly poured concrete, timing of form removal, and temporary heating or ventilating of a building's interior after placement can affect concrete's upward or downward release of free moisture.

One method the roofing industry has historically relied upon to determine a concrete deck's dryness and suitability to be covered with a new roof system is to either mop or pour hot bitumen on the concrete deck's surface. If the bitumen doesn't splatter or froth too much, the deck was considered "dry." Since the roofing industry has largely moved away from hot bitumen-applied roof systems, this method is no longer feasible nor is it reliable.

Another previous method is referred to as the plastic sheet method where a plastic sheet is taped to the concrete's surface and the plastic sheet's underside is monitored for the accumulation of condensation. This procedure is defined by ASTM D4263, "Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method." Field experience has also shown this method to be unreliable.

Research

Research in the flooring industry has shown measuring concrete's internal relative humidity (RH) can be a reliable means of assessing concrete's relative dryness and appropriateness to receive floor coverings. RH values for 65 to 85 percent typically are considered acceptable depending upon the specific floor covering used. Other research has shown normal-weight structural concrete floor slabs may reach acceptable levels in about 90 days and lightweight structural concrete may take about six months to reach equivalent levels. This research and these values are based upon no rewetting (rain) of the concrete during these drying periods.

Applying the flooring industry's methodologies to the roofing industry, NRCA has conducted field instrumentation and monitoring of roof systems experiencing moisture-related problems and found mean RH values in existing concrete roof decks covered with membrane roof systems as high as 89 to 99 percent from 4 to 7 years after construction. These high moisture levels are believed to be attributable to the concrete's original mix water and the concrete not being allowed to dry adequately prior to membrane roof system application.

One significant difference between concrete floor slabs and concrete roof slabs is floor slabs typically experience little moisture vapor drive potential because ambient temperatures (room temperature) normally are nearly the same above and below floor slabs. Conversely, concrete roof decks experience considerable vapor drive because of the temperature differentials across a roof assembly's cross-section -- interior conditions on the bottom side and summer and winter conditions on the building's exterior. This vapor drive potential results in transport of retained moisture from the concrete roof deck into the roof system's components, resulting in roof system deterioration.

Recommendations

Roof system designers and specifiers should be aware of the roofing industry's moisture-related concerns with structural concrete roof decks and include appropriate considerations into their roof system designs and specifications.

Criteria for deciding when a newly placed structural concrete roof deck is suitable to be covered with a new roof system should be established by the project designer and is best included in project specifications.

NRCA recommends a well-adhered vapor retarder be incorporated into roof systems over newly poured structural concrete roof decks to isolate the concrete deck's retained moisture from the roof system components. Experience has shown hot-applied bituminous vapor retarders have performed successfully in this application. When including a vapor retarder over a structural concrete roof deck into a roof system design, care should be taken to avoid roof system types that rely on mechanical fasteners for roof system attachment. Fastener penetrations through a vapor retarder can render the vapor retarder largely ineffective.

Additional information on moisture-related issues with structural concrete roof decks, NRCA's research on the topic and additional design recommendations are provided in the technical section of NRCA's website, www.nrca.net.